A Critical Review on "Invention of Tradition" from an Anthropological Archaeological Perspective: Based on the Study of Iron Slag found in the Cebu Central Settlement, Cebu City, Philippines

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Introduction

Since the 1980s, the tradition of culture has been discussed by numerous authors (e.g., Hobsbawm and Ranger eds., 1983 Talalay 2010, 山下1995). Most of their statements are critical toward the "tradition". At an extreme end, it has been said that almost all "traditions" were invented matters. In this academic atmosphere, it seems to me that discussion concerning tradition went too far from the academic consideration. Therefore, many of the recent arguments concerning "cultural tradition" tend to completely deny the concept of cultural tradition itself, since every "tradition" should politically and so purposefully be created, providing somebody or institution with benefits.

While cultural anthropologists discussing cultural tradition, in the field of archaeology, the concept of "tradition" has also been discussed for a long time (e.g., Cleere ed. 1989; Fagan 1978; Rathje 1980; Renfrew 1991). Archaeologists note continuity seen in material culture, and call it, namely the continuity of techniques "tradition". This concept has long discussed as one of the key concepts to think about the continuity of crafts work, and everyday practice by archaeologists. In this well-established concept, "tradition" has been given a domain that same kind of technology or underlying concept can continue for a certain period in a certain area.

The present paper pursues therefore to examine two different concepts of tradition. By doing so, the paper will argue that the tradition is really invented or not. This examination is particularly important in studies of recent popular topic: cultural heritage. Discussing cultural heritage, researchers always face problems of cultural tradition, and are somewhat confused when thinking about what we have to conserve, preserve, and restore.

In the field of tourism development too, it is of significance to think about the traditional continuity, since it is one of the important tourism resources elsewhere in the world. In this trend, it has been pointed out that fake tradition was created for political or commercial purposes (e.g., Cohen 1996, Talalay 2010, 山下1995). Through these works, we have been well aware that present-day tradition is an important resource for tourism development through which a large-scale economic development is designed; or establishment of national or regional identity is designed.

This paper discusses that the continuity of technical aspects can be detected only through analytical procedure, and the results of analysis may not be politically aware by residents. Rather, the continuity is created through everyday practice which is done for adaptive purpose, not just political purpose. Therefore, present paper intends to exhibit this point by using archaeological data.

I. Cebu Central Settlement

The present research is based on the research which was originally designed to investigate the development of complex societies in Southeast Asia (Nishimura 1984, 1986, 1988, 1989, 1992). For this purpose, I used an archaeological and anthropological information from Cebu Island of the Philippines where a number of archaeological sites around the so-called "lowland area" were discovered (e.g., Bayer 1921, 1948; Doeppers 1972; Evangelista 1979; Fox 1968, 1979; Hutterer 1973a, b, 1974, 1982; Hutterer and Macdonald eds. 1982; Janse 1947; Jocano 1975; Maceda 1973; Phelan 1959; Solheim 1964, 1981; Sullivan 1956; Tuggle and Hutterer eds. 1972; Wernstedt and Spencer 1967).

The Cebu central settlement is the major urban settlement in the lowland area since the Late Prehistoric period. It was located on the downtown area of present-day Cebu City. Although present-day Cebu City has expanded onto the mountainside toward the north and west, the traditional urban core and contemporary downtown area is located on a small alluvial plain, with an elevation of only 3 to 10 m above sea level (Nishimura 1988: 127). Archaeological works (Hutterer 1973a, 1974; Nishimura 1986, 1988, 1992, 1993, 1994, 1999; Tenazas and Hutterer 1968) as well as historical works (e.g., Cullinane 1982; Fenner 1985; Mojares 1983) revealed that Cebu central settlement was a major center of trade for a long time. Originally, anthropological-archaeological research was designed to investigate causal relationship between the development of complex societies and trade activities.

II. Analysis of Iron Slag Samples

A. Iron Slag Data

A total of 1,125 pieces of iron slag were found during the field research in Cebu City (Table 1). The total weight was 5.5748 kg. Among the six localities(1) excavated, only three yielded slag (Table 1). Those three localities are Plaza Independencia; Sto. Niño Church, Inside Courtyard; and Sto. Niño Church, Outside Garden Strip. Among these three localities, however, great differences in the volume of iron slag were observed (see Table 1). As seen in Table 1, a heavy concentration of iron slag was encountered at the Plaza Independencia locality. Since the density of iron slag is much higher at the Plaza Independencia locality than at other localities, metal-working may have taken place at Plaza Independencia. Iron slag pieces found at the localities outside Plaza Independenica might have dispersed from there.

Table 1 Distribution of Iron Slag in the Cebu Settlement

	Plaza Independencia				Sto. Niño Church, Inside Courtyard				Sto. Niño Church, Outside Garden Strip		Total
Sq/Tr.	NOE 1	S2W1	S4W1	Total	NOE 2	S1E9	S2E8	Total	N7E5	Total	
No.	47	4	1056	1107	9	7	1	17	1	1	1125
%	4.2	0.4	93.8		0.8	0.6	0.1		0.1		
Wgt.(g)	555.8	125.3	4249.8	4930.9	585.3	34.4	2.6	622.3	21.7	21.7	5574.9
%	10	2.2	76.2		10.5	0.6	0.1		0.4		

Source: Nishimura 1992

Furthermore, even within the Plaza Independencia locality, there is great variability in the spatial distribution of iron slag. The heaviest concentration of iron slag is observed at Trench S4W1 (Table 1). Thus, iron-working was restricted in a spatial sense in the Late Prehistoric and the Spanish periods(2).

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(1) Those six localities are: Sto. Niño Church, Inside Courtyard, Sto. Niño Church, Outside Garden Strip, Cathedral Plaza, St. Peter Memorial Chapel, Knights of Columbus, Plaza Independencia (Nishimura 1988, 1992).

(2) Through geographical and archaeological surveys, six chronological units were established: the Incipient Late Prehistoric (ca. 10th – 14th centuries A.D.), Early Late Prehistoric (ca. mid-14th – 16th centuries A.D.), Late Late Prehistoric (ca. 16th – 17th centuries A.D.), Early Spanish (ca. 17th – 18th centuries A.D.), Late Spanish (ca. 18th – 20th Centuries A.D), and Modern periods (Nishimura 1992, 2010).

With regard to morphological characteristics of iron slag, a variety of colors are observed in the iron slag samples. According to the Munsell Color Chart, they range from 10YR4/1 through 10YR5/1 through N4/0 to 7.5Y4/2. Generally speaking, the most basic color is gray or grayish olive. There are some spots the color of which sometimes is dark gray, or sometimes bright gray, or sometimes yellowish gray. Here, yellow spots might be the result caused by the attachment of sulfurous materials, while dark gray ones might indicate presence of carbon. However, the colors 10YR4/1 and 10YR5/1 are most common in our samples.

The shape of the slag varies greatly, and is difficult to describe. In general, the shapes resemble peanut shells. They are basically shaped like irregularly elongated bullets with a rough surface. There are many concave or convex parts on the surface. It also has a number of small holes as well as wavy lines. It seems to me that those holes were created when the air which was trapped in the smelted iron escaped in the process of cooling and contraction. Wavy lines might be the result of shrinkage of the surface, again in the process of cooling and contraction.

The size of the holes ranges from less than 1 mm to 5-7 mm. There is a tendency that the larger pieces of slag to have larger holes.

Table 2 Distribution of Iron Slag Plaza Independencia

Sq/ Tren.	S2W1				N0E1				S4W1				Total	
Layer	No.	Dens. (No.)	Wgt. (g)	Dens. (g/m³)	No.	Dens. (No.)	Wgt. (g)	Dens. (g/m³)	No.	Dens. (No.)	Wgt. (g)	Dens. (g/m³)	No.	Wgt. (g)
I	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II	0	0	0	0	1	4	120.3	481.2	2	3.2	13.2	21	3	133.5
III	0	0	0	0	0	0	0	0	17	37.8	71.1	158	17	71.1
IV	2	5.4	8.3	22.4	40	88.9	400.6	890.2	796	564.5	1939.3	1375.39	838	2348.2
Va	1	5	67.8	339	6	20	34.9	116.3	139	132.4	1062	1011.4	146	1164.7
Vb	0	0	0	0	0	0	0	0	48	56.5	271	318.8	48	271
Vc	0	0	0	0	0	0	0	0	26	28.9	418.9	465.4	26	418.9
VI	1	10	49.2	246	_	_	_	_	0	0	0	0	1	49.2
Total	4		125.3		47		555.8		1028		3775.5		1079	4456.6
F500	_	_	_	_	_	_	_	_	2	2000	56	56000	2	56
F501	_	_	_	_	_	_	_	_	4	200	247.5	12375	4	247.5
F503	_	_	_	_	_	_	_	_	1	25	0.9	22.5	1	0.9
F504	_	_	_	_	_	_	_	_	4	33.3	12.4	103.3	4	12.4
F506	_	_	_	_	_	_	_	_	17	141.7	157.5	1312.5	17	157.5
GTotal	4		125.3		47		555.8		1056		4249.8		1107	4930.9

Source: Nishimura 1992

Table 3 Distribution of Iron Slag Sto. Niño Church, Inside Courtyard

Sq/ Tren.	S2E8				S1E9				N0E9				Total	
Layer	No.	Dens. (No.)	Wgt. (g)	Dens. (g/m³)	No.	Dens. (No.)	Wgt. (g)	Dens. (g/m³)	No.	Dens. (No.)	Wgt. (g)	Dens. (g/m³)	No.	Wgt. (g)
I	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II	1	1.3	2.6	3.5	0	0	0	0	0	0	0	0	1	26
F2 Soil	0	0	0	0	0	0	0	0	0	0	0	0	0	0
III	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IV	0	0	0	0	1	2.9	3.1	9.1	9	60	585.3	3902	10	588.4
V	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1		2.6		1		3.1		9		585.3		11	591

Source: Nishimura 1992

Table 4 Distribution of Iron Slag Sto. Niño Church, Outside Garden Strip

SQ	N7E5				Total	
Layer	No.	Dens. (No.)	Wgt.(g)	Dens. (g/m³)	No.	Wgt.(g)
I	0	0	0	0	0	0
II	0	0	0	0	0	0
III	0	0	0	0	0	0
IV	0	0	0	0	0	0
V	0	3.3	21.7	72.3	1	21.7
VI	0	0	0	0	0	0
Total	0		21.7		1	21.7

Source: Nishimura 1992

B. Analysis

a) Classification of Iron Slag Samples

Iron slag is a by-product of iron-working. Therefore before classifying iron slag samples from a functional viewpoint, it might be useful to first consider the process of iron manufacture.

A basic study of iron artifacts discovered at archaeological sites in the Philippines has been conducted by Eusebio Z. Dizon, senior researcher of the National Museum of the Philippines (Dizon 1981, 1983). According to him, metallurgically there are at least two types of iron in the archaeological samples found in the Philippines. They are wrought iron, and cast iron (Dizon 1981, 1983).

Wrought iron is melted iron which does not include carbon. Wrought iron is often obtainable before the iron becomes “steel”.

On the other hand, steel is collective term which describes a kind of iron that has a low carbon content due to firing at a relatively low temperature. Citing Hodges (Hodges 1976:83), Dizon states that wrought iron can be converted into steel by allowing it to absorb carbon (Dizon 1981:47).

Cast iron is ore which has been melted at a relatively low melting point (ca. 1150℃)(Dizon 1981:53). This means that it contains a high level of carbon. In order to obtain this sort of iron, a sophisticated furnace for processing iron ore is necessary. One type of such furnaces is called a “blast furnace”. A blast furnace is air tight, with air being pumped into this enables one to attain a high temperature for processing iron. This kind of sophisticated facility and the necessary iron-processing techniques were used only by the Chinese in prehistoric times, especially before the Christian era (e.g., Dizon 1981). Even well into historic times, this technique of iron-manufacture was used only in China.

Although iron wastes might be yielded in the process of making wrought-iron, such wastes must be different from “iron slag”. Iron slag is produced only in the process of iron-smelting. The practice of smelting of iron ore is common throughout the Philippines. The iron ore-smelting is regarded as the preparation work for making wrought-iron. The iron-smelting in the Philippines is carried out by a relatively simple techniques. Iron craftsmen dig a pit on the ground, put iron ore and fuels such as charcoals together, and fire them.

In order to identify iron slag recovered in the Cebu settlement as by-product of iron-smelting, it was necessary to measure the chemical contents of the slag samples. For this purpose, I sent eight slag specimens, which were randomly chosen from the iron slag assemblage found at Trench S4W1 of the Plaza Independencia locality to the Institute of Archaeology, University College, London. As seen in Tables 1 and 2, Trench S4W1 of the Plaza Independencia locality yielded the most slag samples, and slag fragments were distributed in almost every layer dated from the Early Late to the Modern periods.

Here, I concentrated to analyze the iron slag samples found at Plaza Independencia mainly by using an approach analogous to research of iron slag done by other researchers on iron slag recovered at their sites. For this purpose, I used particularly the information provided from other archaeological sites located on the similar environmental settings, namely, lowland coastal area in Southeast Asia. By Harrisson and O’Connr (1969), and by Hutterer (1973).

The information provided by Hutterer was especially useful, since iron slag fragments found at localities which he and Tenazas excavated were adjacent to Plaza Independencia, and so those slag fragments may also be considered to have dispersed from the possible workshop at Plaza Independencia. Therefore, iron slag fragments found through my field research are identical to those found at the Magallenes St. and Lapu-lapu St. localities in the excavations conducted by Tenazas and Hutterrer (Hutterer 1973a). A chemical analysis was conducted for the slag samples found at these localities by Fawcett and Ungab, and the result was published (Hutterer 1973a: Appendix III) (Table 5). This chemical analysis indicates that a relatively large quantity of silicon and calcium are included in this slag. When Dizon analyzed iron slag samples at the Cortez site in Camalaniugan, Cagayan, he discovered that the slag also included traces of silicates. In his explanation of the presence of silicates, he states, “the method of production of the iron as material was still imperfect” (Dizon 1981:60).

Table 5 A Chemical Analysis of Iron Slag Samples Found in the Cebu Settlement

Element	Iron Slag		Sherds 1	
	I	II	I	II
Silicon	7.08	21.98	33.77	27.55
Iron	27.75	22.49	6.11	8.41
Calcium	4.77	8.89	5.71	4.48
Magnesium	1.48	2.02	2.53	1.59
Aluminum	4.47	4.89	4.86	12.57
Manganese	0.22	0.09	0.23	0.51
Sulfur	tr.	none	tr.	none

Note 1: “Sherds” mean iron slag attached to earthenware sherds.
Source: Fawcett and Ungab, 1973: Appendix III, (in Hutterer 1973b). (Partially modified).

A similar statement was made by Harrisson and O’Connor in their technical report on iron-working sites in Western Borneo. They state, “slag, whatever the source, consists largely of silicates, resulting mainly from silica combining under heat with the metallic oxides not useful to the end product – in this delta case, the end product of iron” (Harrisson and O’Connor 1969:25).

Table 6 A Chemical Analysis of Iron Slag Samples Found at the Buah and the Santubong Sites in Western Borneo

Mineral	"Buah, 1961 D/A 17, 48-60" % content	"Santubong," 1969 (no locality) % content
Ferrous Oxide ("iron")	57.13	65.5
Silica	31.43	22.4
Aluminum	8.05	7.6
Calcium ("lime")	0.42	2.3
Manganese	0.4	___
	0.17	___
Copper	0.01	___
Titanium	0.01	___
H2O, etc.	2.4	2.2

Source: Harrison and O'Connor, 1969: 190

Harrisson and O'Connor further state that this type of silicate slag is primarily the residue of smelting operations which produce wrought iron from ore (Harrisson and O'Connor 1969:68). Therefore, as an ethnographic example in Borneo indicates that in some case, this smelting can be further worked into a wrought iron (Harrisson and O'Connor 1969).

The iron slag fragments discovered in the Cebu settlement are almost identical to those recovered at the sites in Western Borneo. A comparison of the chemical contents of the slag in both regions also indicates that both regions yielded quite similar iron slag (Table 6). This fact further leads us to assume that the iron-working techniques themselves were similar between the two regions.

Harrisson and O'Connor investigated three iron-working sites: the Jaong, the Buah, and the Bonkisam sites. The iron-working at these sites, spanned different time periods, ranging from about the 9th to the 14th centuries. The excavators found not only slag, but also implements for iron-working, including fragments of the so-called "clay crucibles". On the basis of archaeological evidence, the excavators suggest that the iron-working techniques at the above three sites was relatively simple. They state:

> The deposition and the morphology of this slag, at one end of the scale in multifinger, finger, and droplet; at the other in cakes, rather suggests a largish, open hearth system of

smelting rather than any elaborate, enclosed kiln or oven (Harrisson and O’Connor 1969:69).

At Plaza Independencia in the Cebu settlement where we found the greatest concentration of iron slag, we did not find any structure which indicated an “elaborate, enclosed kiln or oven”. Therefore, it is suggested that the iron-working technique employed there was also associated with a relatively simple open hearth method. Although the archaeological evidence to positively support this proposition is still missing, there are archaeological features – F504 and F506 – found in the layers in which a heavy concentration of iron slag was observed at Trench S4W1 of Plaza Independencia (Table 2). We observed that the density of iron slag in these features, especially in F506, was relatively high. The feature consists of a slightly concaved pit which was shallowly dug into the ground, and therefore the boundaries of the feature were not quite clear. Although I did not clearly observe indications that the walls as well as bottom of the pit were burned by intensive firing, the soil of all these areas was crispy and a little tough. These phenomena were perhaps due to constant exposure to an extremely hot fire. Therefore, under this circumstance, I would like to conclude that, as in the case of iron-working sites in Western Borneo, the archaeological evidence recovered in the Cebu settlement indicates that the main process of iron-working there was to smelt iron ore.

Regarding another process of iron-smelting, Harrisson and O’Connor suggest that clay crucibles were used at their sites in Western Borneo. According to them, a clay crucible is cone-shaped with a flat base ware, in which wrought iron was put and heated to refine to make steel. Clay crucibles found in Borneo were about 65 – 45 mm in the rim diameter; about 55-35 mm in the base diameter; about 25-10 mm in wall thickness; and about 40-14- mm in height (Harrisson and O’Connor 1969:106-136). They were made from a relatively coarse clay.

In the Cebu settlement, we did not find any positively identifiable fragments of crucibles. However, at Trench S4W1 of Plaza Independencia, layers such as Layers IV, Va, and Vb, which yielded large quantities of iron slag, we found several yellow clay lumps. These clay lumps were quite eroded, and therefore it was almost impossible to identify their original function. These are possible fragments of clay crucibles. The size of these clay lumps is small, and there are only three to four of them, not statistically significant. More samples obtained through steady careful, detailed field research will be needed to reach a definite conclusion concerning their function.

As a result, I conclude that iron-working activities in the Cebu settlement were primarily related to the processing of iron ore – iron-smelting. While a few pieces of slag might have been produced in the process of another kind of iron-working – making wrought iron, most of the pieces of iron slag recovered were by-products created through the process of iron-smelting. Here, it is of great importance to note that the archaeological evidence recovered at Plaza Independencia indicates that the basic techniques of iron-smelting did not change from the Early Late Prehistoric to the Late Spanish periods.

Therefore, although iron slag fragments in each layer shows great variability in color, form, and size, I included all iron slag pieces as one category, quantified them by weight, and compared the deviation in their weight between layers. A main purpose of such quantification is to see variability in the iron-working process, and in iron-working techniques which should be tangible through the analysis of slag. In doing so, I would like to examine the continuity of technique and variability in it.

One proposition about change in technology through time which can be considered here is that discussed by White (1971). If we define the advance of manufacturing technology as increase in efficiency of the harnessing of energy-matter from the environment (e.g., White 1971), we then expect to see at least two phenomenon: 1) the pursuit of production of better quality goods in larger quantities; and 2) the minimization of waste, and maximization of efficiency of energy-matter use. It is well-known among researchers that these two phenomenon can often be attained not only through substantial development of the manufacturing technology itself, but also through the improvement of techniques of managing manufacture, and the development of a better regulatory organization for manufacturing activities.

b) Analytical Procedure and Results

There was a great variety of sizes among the iron slag samples recovered in the Cebu settlement. Some pieces are as small as the tip of the little finger, while some are as large as half of a baseball.

On the basis of a histogram analysis of the weight, we can classify slag samples into at least four ranks (Table 7). These ranks are as follows: Rank 1 (Small) is lighter than 4 g; Rank 2 (Medium) is 5 to 9 g; Rank 3 (Large) is 10 to 20 g; and Rank 4 (Largest) is heavier than 21 g.

Table 7 Iron Slag: Rank Size Distribution Plaza Independencia

Sq/Tren	S2W1				N0E1				S4W1			
Rank	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Layer	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
I	0	0	0	0	0	0	0	0	0	0	0	0
II	0	0	0	0	0	0	0	1	0	1	1	0
III	0	0	0	0	0	0	0	0	9	6	2	0
IV	1	1	0	0	20	9	7	4	700	65	20	11
Va	0	0	0	1	1	4	1	0	94	21	9	15
Vb	0	0	0	0	0	0	0	0	28	14	4	2
Vc	0	0	0	0	0	0	0	0	6	6	10	4
VI	0	0	0	1	0	0	0	0	0	0	0	0
Total	1	1	0	2	21	13	8	5	837	112	45	32

Legend:
Rank (1) > 4g (Small)
(2) 5-9g (Medium)
(3) 10-20g (Large)
(4) <21g (Largest)

Source: Nishimura 1992

In order to examine diachronic aspects of the manufacture of iron goods, only samples from Trench S4W1 of the Plaza Independencia locality were examined for three reasons: a) this trench has the heaviest density of iron slag, and so the sample size is large enough to be stratified into chronological units (layers) for the present purpose of the research; b) iron slag was found continuously from Layer II to Vc in this trench, and so it is possible to analyze samples in all chronological contexts; and c) the chronological units have been well-confirmed for this location through analysis of the stratigraphy and artifact assemblages, so it is easy to date slag samples from this trench. As Table 7 shows, the majority of the iron slag samples from Layer II to Layer Vc fall in Rank 1 (lighter than 4 g). However, analysis of the distribution of size classes layer by layer shows that there is a trend from the upper layers to the lower layers: that is, in the lower layers representing older time periods, iron slag tends to be larger, and shows more disparity in size.

In order to clarify this point, I prepared an Analysis of Variance (ANOVA) on the basis of a single variable: weight (Table 8). As Table 8 shows, we observe a major trend of increasing variance with increasing antiquity. We also observe that there is great variability in the weight of samples from layer to layer. In order to test this observed variability statistically, I performed a Modified Levene's Test. The Levene's Test is particularly useful to measure the equality of variance, and so to examine, for instance, the similarity in given variables between two sets of samples which have a skewed distribution with a long tail (e.g., Brown and Forsythe 1974: 364-367). In our case, it is observed that the distribution of the sizes of slag pieces is extremely skewed in the samples for each layer. Since the main purpose of this analysis is the measurement of the equality of variance, which requires comparison on the basis of the median value, non-parametric statistics are not appropriate for my analysis at the time because non-parametric statistics are primarily concerned with comparison on the basis of the mean value. In a case such as the present one, therefore, Levene's statistical method is appropriate since it is quite robust for this kind of data (e.g., Brown and Forsythe 1974:364-367).

Table 8 Iron Slag Variance of Weight Plaza Independencia, S4W1

Period	Modern	Late Spanish	Early Spanish	Late Late Prehistoric	Early Late Prehistoric
Layer	II	III	IVa + IVb	Va + Vb	Vc
No. of Samples	2	17	796	187	26
Variance	12.5	17.5	49.8	218.7	526.4
Mean	6.6	4.2	2.4	7.1	16.1

Source: Nishimura 1992

The analytical procedure which was followed to apply Levene's Test to my data is as follows:

First, partially because the sample size in Layer II is extremely small (2 pieces), and partially because this layer is disturbed, I excluded Layer II from this analysis.

In addition, I combined the samples discovered in Layer IVa and IVb, and those in Layer Va and Vb, since it was necessary to standardize the chronological units for further comparative studies with other kinds of archaeological remains. Therefore, the samples in four layers – Layer III, Layers IVa + IVb (hereafter designated Layer IV), Layers Va + Vb, and Layer Vc – were compared.

Second, in order to measure the statistical distance of the samples from the center of the distribution, two steps were taken: a) I measured the median of the samples in each layer, as follows:

Layer III: 3.9 g

Layer IV: 1.0 g

Layers Va + Vb: 2.5 g

b) I subtracted this median value from the weight of each samples. In doing so, I obtained the residual of each sample.

Third, I ran a series of one-way ANOVA to compare each two sample sets. That is, I wanted to measure the equality of variance between layers. An ANOVA examines the following two hypotheses:

H0: $\sigma 1 = \sigma 2$

H1: $\sigma 1 \neq \sigma 2$

At $\alpha = 0.1$, if the significant level is larger than the α value, the null hypothesis is rejected. That is, the variance of the iron slag sizes between a pair of layers is not significantly different. In this case, $\sigma 1$, $\sigma 2$, $\cdots$, σn are variances of the weight of the samples taken from individual layers.

Through this analysis, we can also see a trend in the change of variance from layer to layer, that is, period to period, by comparing the significance levels shown in the ANOVA table. Given the propositions mentioned above, more larger pieces of slag and higher variability in size in earlier periods, we expect to see a trend toward the reduction of the significant level of variance through time.

I conducted four sets of ANOVA tests: a) comparison of all layers: b) comparison between Layers III and IV; c) comparison between IV and Va + Vb; and d) comparison between Va + Vb and Vc. The results of these tests are shown in Tables 9 - 12.

The results are particularly interesting in two points:

a) As seen in Table 9, the analysis of variance of slag samples in all layers indicates that the variance between layers is significantly different. Therefore, the result of this ANOVA test supports our first observation that the size of iron slag greatly varies from layer to layer, i.e., through time.

b) More interestingly, through these analyses, we can observe the magnitude of the difference between layers. Namely, we see that the result of the test is continuously significant, and that there is a trend that the significance level becomes smaller – that is, the difference of the variance of slag size becomes larger – from the Early Late Prehistoric through the Late Late

Table 9 Analysis of Variance of Iron Slag Plaza Independencia, S4W1

ANALYSIS OF VARIANCE OF RESIDUALS N=1026 OUT OF 1027

SOURCE	DF	SUM OF SQRS	MEAN SQR	F-STATISTICS	SIGNIF
BETWEEN	3	4790.2	1596.7	18.774	.0000
WITHIN	1022	86921.	85.050		
TOTAL	1025	91711.	(RANDOM EFFECTS STATISTICS)		

ETA= .2285 ETA-SQR= .0522 (VAR COMP=12.145 %VAR AMONG=12.50)

LAYER	N	MEAN	VARIANCE	STD DEV
III	17	2.8588	8.8463	2.9743
IV	796	1.8755	48.296	6.9495
Va+Vb	186	6.0273	203.74	14.274
Vc	26	11.942	419.52	20.482
GRAND	1026	2.9036	89.474	9.4591

Source: Nishimura 1992

Table 10 Analysis of Variance of Iron Slag Plaza Independencia, S4W1 Comparison between Layers III and IV

ANALYSIS OF VARIANCE OF RESIDUALS N=813 OUT OF 814

SOURCE	DF	SUM OF SQRS	MEAN SQR	F-STATISTIC	SIGNIF
BETWEEN	1	16.094	16.094	0.3387	.5607
WITHIN	811	38537.	47.517		
TOTAL	812	38553.	(RANDOM EFFECTS STATISTICS)		

ETA= .2285 ETA-SQR= .0522 (VAR COMP=12.145 %VAR AMONG=12.50)

LAYER	N	MEAN	VARIANCE	STD DEV
III	17	2.8588	8.8463	2.9743
IV	796	1.8755	48.296	6.9495
GRAND	813	1.8961	47.479	6.8905

Source: Nishimura 1992

Table 11 Analysis of Variance of Iron Slag Plaza Independencia, S4W1 Comparison between Layers IV and Va+Vb

ANALYSIS OF VARIANCE OF RESIDUALS N=983 OUT OF 984

SOURCE	DF	SUM OF SQRS	MEAN SQR	F-STATISTICS	SIGNIF
BETWEEN	1	2610.2	2610.2	33.563	.0000
WITHIN	981	76292.	77.769		
TOTAL	982	78902.	(RANDOM EFFECTS STATISTICS)		

ETA=.1819 ETA-SQR=.0331 (VAR COMP=8.3618 %VAR AMONG=9.71)

LAYER	N	MEAN	VARIANCE	STD DEV
IV	796	1.8755	48.296	6.9495
Va+Vb	187	6.0273	203.74	14.274
GRAND	983	2.6653	80.348	8.9637

Source: Nishimura 1992

Table 12 Analysis of Variance of Iron Slag Plaza Indendencia, S4W1 Comparison between Layers Va+Vb and Vc

ANALYSIS OF VARIANCE OF RESIDUALS N=213 OUT OF 213

SOURCE	DF	SUM OF SQRS	MEAN SQR	F-STATISTIC	SIGNIF
BETWEEN	1	798.64	798.64	3.4828	.0634
WITHIN	211	48384.	229.31		
TOTAL	212	49183.	(RANDOM EFFECTS STATISTICS)		

ETA= .1274 ETA-SQR= .0162 (VAR COMP=12.471 %VAR AMONG=5.16)

LAYER	N	MEAN	VARIANCE	STD DEV
Va+Vb	187	6.0273	203.74	14.274
Vc	26	11.942	419.52	20.482
GRAND	213	6.7493	232	15.231

Source: Nishimura 1992

Prehistoric to the Early Spanish periods. It is especially notable that the difference between Layers IV and Va + Vb is highly significant (Table 11). Thus, aspects of the manufacture of iron goods changed greatly from the Late Late Prehistoric to the Early Spanish periods.

Then, once this major change in iron-working was established in the Early Spanish period, the rate of change appears to have decreased (Table 10). Thus, we see that the difference in the variance of slag size between Layers III (Late Spanish period) and IV (Early Spanish period) is not significant.

In order to interpret the patterns observed through the analysis, I would like to suggest two points:

First, by the time Spanish rule began around Cebu, iron-working techniques had reached a certain sufficient quality, which can be seen in the reduction of variance from the Early through the Late Late Prehistoric to the Early Spanish periods. Thus, we note that the quality of iron-working improved steadily through time (Table 9).

With the beginning of the Spanish period, however, we see a difference in the variance of the weight of slag samples. The difference of the variance among the slag samples from the Late Late Prehistoric to the Early Spanish periods is notably large. It is known from historical documents that Spanish rulers requested local craftsmen in Cebu to make iron goods such as building materials and tools based on Spanish prototypes (e.g., Tenasaz 1965).

On the basis of the results of this analysis of iron slag samples and historical records, at least two points can be made:

1) The Spanish were able to use local craftsmen to produce their iron goods because the iron-working techniques of the Cebu craftsmen were already sufficient to meet quality demands imposed by the Spanish rulers.

2) Further, a shift to large scale production of iron goods appears to have come only after the beginning of the Spanish period, and so major increases in production quantity came after production quality reached a certain level of standardization.

Second, as mentioned above, the variance was continuously and rather dramatically reduced from the Early Late Prehistoric up to the beginning of the Early Spanish periods, for about 250 years. This major reduction of variance must be due to at least three things: 1) improvement of iron-working techniques; 2) influence of some agents external to iron-working such as the increasing intensity of traffic around the area of the iron-workshop, resulting in increased fragmentation of iron slag by trampling; and 3) development of improved management techniques controlling iron-working activities.

The first proposition can be tested primarily by chemical and physical analyses of slag. Since I could not obtain any report on chemical analyses from a laboratory, I have to withhold any definite conclusions concerning this problem. However, as far as the archaeological evidence is concerned, in the existence of archaeological features (F504 and F506) which might have been open hearths used for iron-working. In the composition of artifact assemblages from the Early Late Prehistoric to the Late Spanish periods, it is difficult to see drastic changes in iron-working techniques, such as the change from the open hearth to closed furnace smelting method, through time in the Cebu settlement. Therefore, I conclude that there is only a small probability that the first proposition for explaining the shift of variance of the size of iron slag pieces is true.

The second proposition is more plausible. A piece of iron slag is brittle, and so easily broken. If there were heavier traffic in one period than in other periods, the iron slag in this period would receive more trampling by human feet. As a result, we would see smaller pieces of iron slag in that period than in other periods.

In this case, a number of small pieces of slag were concentrated particularly in the layers (Layers IVa and IVb) dated to the Early Spanish period (Table 2). Looking at other artifacts in this period, however, we see two contradictions to our second proposition. First, if heavy traffic existed in the Early Spanish period, and trampled the iron slag into smaller bits, we have to assume that this trampling, the resultant breakage should have equally affected the other archaeological remains recovered at this particular locality in the same layer. In fact, many other remains, such as earthenware shards or animal/fish bones which are to some extent more fragile than iron slag, are almost the same in size as in other periods. The breakage ratio of these remains is not very different from that in other periods.

Second, heavy traffic is often detected through heavy disturbance of the ground soil. Continuous trampling often makes artifact fragments and gravel smooth and round. In addition, the color of soil which has been subjected to heavy traffic is usually darker, as, through continuous mixing of the soil with organic matter, the soil becomes more packed. We did not observe any of the above phenomenon in our archaeological record for layers of the Early Spanish period.

Therefore, it is not likely that our second proposition is the best explanation for the shift of the variance of slag weight through time.

As a result, the third proposition provides us with the most plausible explanation for the change of the variance of iron slag weight. More specifically, the observed reduction of the variance of iron slag sizes through time can reasonably be assumed to be due to the development of management techniques, which are important variables to improve the quality level of craft production in complex socio-cultural systems. That is, more concretely, the development of regulatory subsystems which operate to channel information and energy/matter in the Cebu settlement systems would be another factor to cause this major change. For example, the amount of variance in size of slag might be related to the development of specialized regulators, such as a headman of the craftsmen group. This overseer might have had responsibility for supervising craft production activities, and by doing so, had responsibility for standardizing products. Here, through the analysis of iron slag, we can perceive the development of the socio-economic and socio-political systems in which the Cebu settlement was involved during late prehistoric times.

III. Interpretation of the Results of Analysis

The analysis of the iron slag found in the Cebu settlement through archaeological field research yielded the following results.

a) An iron-working industry existed in the southern part of the Cebu settlement since the Early Late Prehistoric period, and had a long continuity of iron manufacturing. The iron-working industry was established sometime around the 14th century A.D., and was continuously in operation until the very beginning of the Modern period.

b) Since the quantity of iron slag varies greatly from layer to layer, the volume of production of iron goods was apparently quite different in each period. The peak of production came in the Early Spanish period, around the 17th century A.D.

c) The distribution of iron slag was limited to a small area in the Cebu settlement. In fact, even within one locality (Plaza Independencia), the spatial pattern of the distribution is quite skewed. From this evidence, we suggest that the iron-working industry was carried out only by a small number of craftsmen who specialized in manufacturing iron goods. Moreover, given that the iron-working industry had a long tradition, and that the distribution of iron slag was quite restricted in a small area, we can assume that the techniques for the manufacture of iron goods were not widely known. They may, indeed, have been of restricted access, controlled by a regulatory unit. It would be very possible, therefore, that the craftsmen were enclosed within a small residential unit, and kept under tight administrative control. Here, it is of great importance to note that analyses of the Asian trade porcelain from the various localities in the settlement indicate that the quantity as well as quality of the porcelain assemblage discovered at Plaza Independencia in the Early Late Prehistoric through the Late Late Prehistoric to the Early Spanish periods was greater/higher than that in other localities. These porcelain pieces may not have been possessed by the craftsmen themselves, but probably belonged to the administrators who controlled that craftsmen group in situ.

d) In order to examine the technological aspects of iron manufacture, I measured the weight of all slag samples, and compared the variance of the weights of the samples in stratigraphic contexts. As Table 8 shows, there are significant changes in the variances of the weight of slag between layers. The quality of the production of iron goods improved from period to period through time, and further that increases in the quantity of production might have followed the increases in the quality level as well.

e) More interestingly, the variance tends to decrease as the period approaches modern times. I would like to propose a reason to elucidate this pattern:

On the basis of patterns detected through analyses of the entire archaeological assemblage, we can assume, that the basic iron-working techniques did not drastically change from the Early Late Prehistoric to the Late Spanish periods. Therefore, if the change was not created through the development of substantial new manufacturing techniques an alternative proposition is necessary to explain the pattern of the reduction of the variance in slag weight. This alternative explanation is that through time management techniques for productive activities became better organized by the development of regulatory subsystems of productive activities in general. Productive activities were more efficiently controlled, by regulators in particular (e.g., headman of the craftsman group), and so attributes seen in the wastes, such as iron slag, became more standardized.

This phenomenon is more apparent from the Late Late Prehistoric to the Early Spanish periods. Since the basic techniques of iron-working appear to have been the same in both periods, the massive increase in the production of iron goods, and the improvement of the quality in the process of manufacturing iron goods must be correlated to the development of the management technique for the whole process of iron-working. The management of production by the regulatory unit had greatly re-organized, and the regulators controlled the iron-working process more efficiently, resulting in higher rates of production and better quality goods with less waste.

f) The analysis of iron slag provides information by which we can elaborate the propositions: three propositions can be presented with regard to the distribution of iron artifacts in the Cebu settlement.

Through our analysis of the spatial patterns of distribution of iron slag, we have observed that the distribution of iron slag is concentrated in a very restricted area.

In contrast, we observed that iron artifacts were distributed widely throughout the Cebu settlement. If these artifacts were used as raw materials for iron-working, the spatial pattern of the distribution of these artifacts should be correlated with the iron slag. However, there is no correlation between the two types of iron objects. Therefore, I conclude that the iron artifacts found in the Cebu settlement were not used as raw materials for iron-working.

The artifacts are more likely to have been the products of the same iron making process which produced the slag as a by-product, we cannot conclude definitely that those iron artifacts were made at Plaze Independencia. However, it would have been extremely important for administrators to monopolize iron-working techniques as well as personnel. Therefore it is easily imagined that the distribution of iron artifacts was also subject to administrators' monopolization. The quantity, quality and variety of iron artifacts available to inhabitants of the Cebu settlement must have been tightly controlled by administrators. Control of the production of iron artifacts must have preceded their distribution to members of the Cebu settlement and to the settlements in the hinterland area. The easiest way to do this would have been to let the craftsman group within each regulatory unit produce iron artifacts needed by other members of the unit. Therefore, it is likely that the iron artifacts found in the excavations were produced within the Cebu settlement.

It is extremely important to note that the iron artifacts discovered in the Cebu settlement were all practical implements used in the members' daily life. Thus, the monopolization of not only the distribution, but also the production of such utilization iron goods constituted an essential part of the mechanism by which higher order administrators of the Cebu settlement systems achieved and maintained socio-political control.

g) Examining the results of the analysis, especially the deviation of variance through layers, I note a distinctive pattern: although, as mentioned above, the weight of slag has been continuously reduced from layer to layer, the deviation seen in the variance among the slag pieces within a layer is comparatively constant. Interestingly, this consistency does not change even if the weight of slag significantly reduced during the term from the Late Spanish to Modern periods. From this evidence, I would like to induce a proposition: the reduction of the weight of slag progressed through all periods in the progress of technological refinement, while the main skill of iron-manufacturing technique itself is consistently same.

IV. Conclusions

As mentioned in the very beginning of this paper, the main purpose of this paper is to critically re-think of the concept of "tradition" of culture from an anthropological archaeological perspective. For this purpose, I used the iron slag samples excavated at localities of the Cebu settlement, exhibiting the results of quantitative analysis of those.

Based on the results, I would like to come back to examine our primary research question, and add my discussion on the tradition of culture.

Through the analysis of iron slag and consideration of the results of a series of analyses, we see repeatedly-emerging patterns in iron-making practice in the Cebu settlement. Those patterns are consistently observed from time to time, and from place to place.

It seems to me that those patterns are not necessarily made by craftsmen with some political intention. Rather those patterns are the results of everyday practice for a long time. In doing so, craftsmen may not have intended to create the tradition, but actually they did. Through repeating to apply the same kinds of techniques, the practice is embodied in craftsmen. On the basis of this evidence, we would like to argue that the long-term practice would be unconsciously performed. Like adaptive process (Cohen 1974; Kottak 2000), practical patterns can be observed only by third parties such as anthropologists or historians through their research. And probably it is this unconsciously embodied and repeated practice that we have called "tradition".

In this regard, I would like to argue that the concept of "tradition" should be divided into two kinds: on the one hand, there is the tradition which is materialistically measurable and detected as the continuity of practice; on the other hand, there is the tradition which was created for the purpose of socio-political use. The latter type of tradition may be called "politically-invented tradition". Recent arguments on tradition pay attention to the latter type, discussing their political aspects. Through their arguments, however, it seems to me that they mixed up two types of tradition. As a researcher who is engaged in the heritage studies, I would like to emphasize that the discriminate the first type of tradition from the latter type is quite important, since the invention of tradition is after all the outcome of modernization. It is therefore connected to the national or regional government policy such as unification of nation, or creation of symbol of national identity, or tourism development.

The invented tradition is a good and useful conceptual tool by which those policy makers can manipulate the public (Hobsbawm and Ranger eds. 1983). Anthropologists who have to deal with a whole aspect of people's daily practice, it is not enough to see the modern event. Anthropologists need to see deeper historical roots of an event, and if so, we cannot look over repeatedly-emerging patterns in human practice and the result of it (i.e., materialistic objects). Anthropologists cannot help further to speculate a reason behind it. As one of such anthropological works, the present paper demonstrated that there is a "tradition" which is nothing to do with political intention.

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